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[54] **METHOD AND APPARATUS FOR MINIMIZING EMULSION FORMATION IN A PUMPED OIL WELL**

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[51] **Int. Cl.**[7] **E21B 43/00**

[52] **U.S. Cl.** **166/265**; 166/105.5; 210/512.1; 417/313; 418/48

[58] **Field of Search** 210/512.1, 512.2, 210/512.3, 788; 166/265, 369, 105.5; 417/48, 410.1, 424.2, 313; 418/48

[56] **References Cited**

U.S. PATENT DOCUMENTS

2,214,064	9/1940	Niles	166/54
2,281,801	5/1942	Reynolds et al.	166/306
2,910,002	10/1959	Morgan	166/54.1
2,986,215	5/1961	Barr	166/67
3,167,125	1/1965	Bryan	166/306
3,333,638	8/1967	Bishop	166/306
3,363,692	1/1968	Bishop	166/306
3,677,665	7/1972	Corkill	417/48
3,977,469	8/1976	Broussard et al.	166/266
4,047,539	9/1977	Kruka	137/13
4,241,787	12/1980	Price	166/105
4,251,191	2/1981	Gass et al.	166/54
4,295,795	10/1981	Gass et al.	166/111
4,296,810	10/1981	Price	166/105.5
4,480,686	11/1984	Coussan	166/117.5
4,545,731	10/1985	Canalizo et al.	417/86
4,745,937	5/1988	Zagustin et al.	137/13
4,749,034	6/1988	Vandevier et al.	166/369
4,753,261	6/1988	Zagustin et al.	137/13
4,766,957	8/1988	McIntyre	166/265
4,773,834	9/1988	Saruwatari	418/48
4,793,408	12/1988	Miffre	166/53

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

2 194 572	3/1988	United Kingdom .
2 248 462	4/1992	United Kingdom .
WO 97/25150	7/1997	WIPO .

OTHER PUBLICATIONS

T. Kjos et al., SPE Paper No. 030518, Society of Petroleum Engineers, 1995, pp. 689–701.

B.R. Peachey et al., Downhole Oil/Water Separation Moves Into High Gear, 37 Journal of Canadian Petroleum Technology, Jul. 1998, pp. 34–41.

James F. Lea et al., What's new in artifical lift; Part 2; advances in electrical submersible pumping equipment and instrumentation/control, plus other new artificial lift developments, World Oil, Apr., 1996, pp. 47–56.

Miller, *The American Oil & Gas Reporter,* Jan., 1997, p. 76–80.

Miller, *The American Oil & Gas Reporter,* Mar., 1997, p. 106–109.

Stuebinger et al., SPE Paper No. 38790, Society of Petroleum Engineers, 1997, pp. 1–10.

MBC Inc., Introducing a Concurrent Process of Gs Production/Water Disposal, 10 pages. (undated).

Reda, *Downhole Dewatering Systems,* 6 pages, 1997.

Chriscor, a division of IPEC Ltd., *Chriscor Downhole Water Injection Tool,* 3 pages. (undated).

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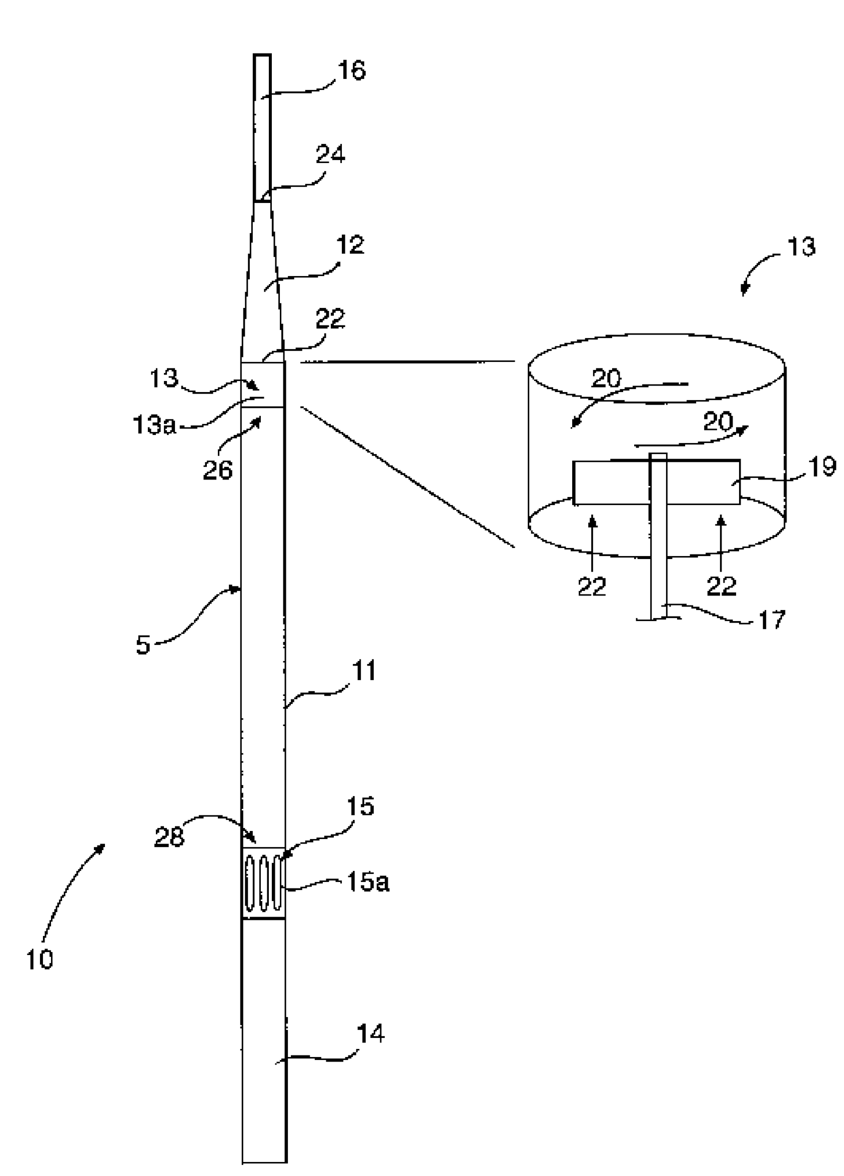
[57] **ABSTRACT**

The present invention relates to a system for minimizing emulsion formation in a pumped oil well by establishing substantially core annular flow at the outlet of the system. The core annular flow regime is established at the outlet of the system through a combination of a pump outlet and a transition conduit.

22 Claims, 2 Drawing Sheets



U.S. PATENT DOCUMENTS

4,818,197 4/1989 Mueller 418/48
4,832,127 5/1989 Thomas et al. 166/106
4,913,630 4/1990 Cotherman et al. 417/313
5,159,977 11/1992 Zabaras 166/105
5,176,216 1/1993 Slater et al. 166/105.5
5,224,837 7/1993 Lamphere et al. 417/63
5,335,732 8/1994 McIntyre 166/313
5,425,416 6/1995 Hammeke et al. 166/108
5,431,228 7/1995 Weingarten et al. 166/357
5,497,832 3/1996 Stuebinger et al. 166/369
5,562,405 10/1996 Ryall 415/72
5,579,838 12/1996 Michael 166/186
5,667,686 9/1997 Schubert 210/512.1
5,697,448 12/1997 Johnson 166/369
5,755,554 5/1998 Ryall 415/199.5

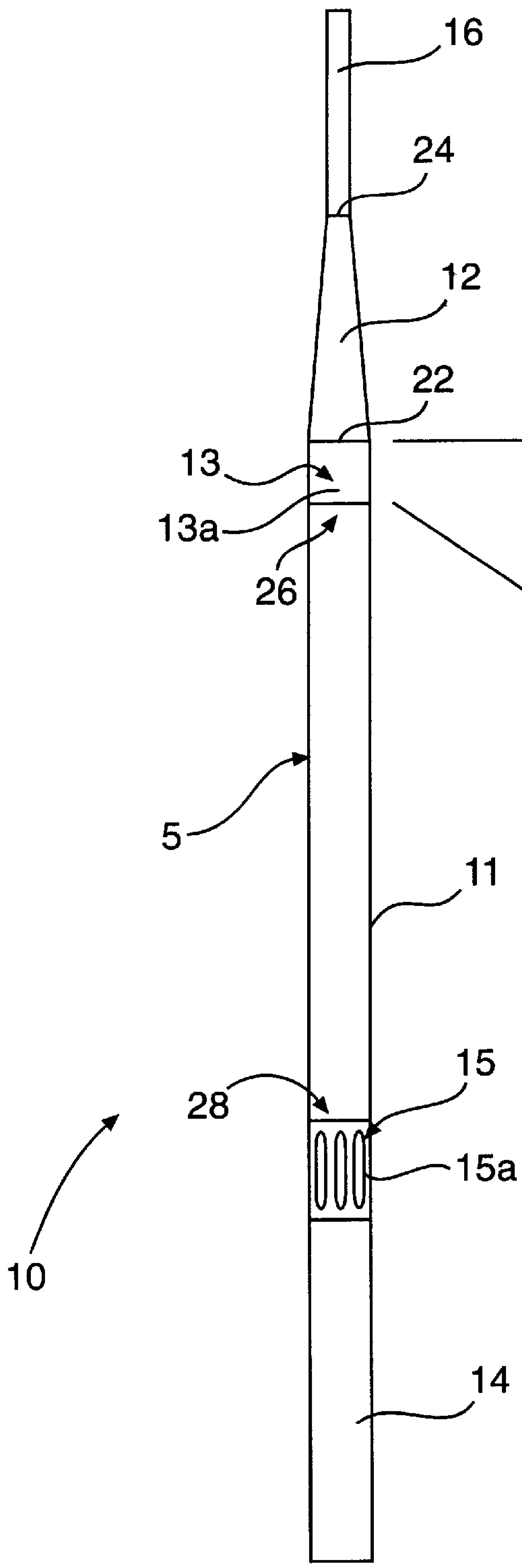


FIG. 1A

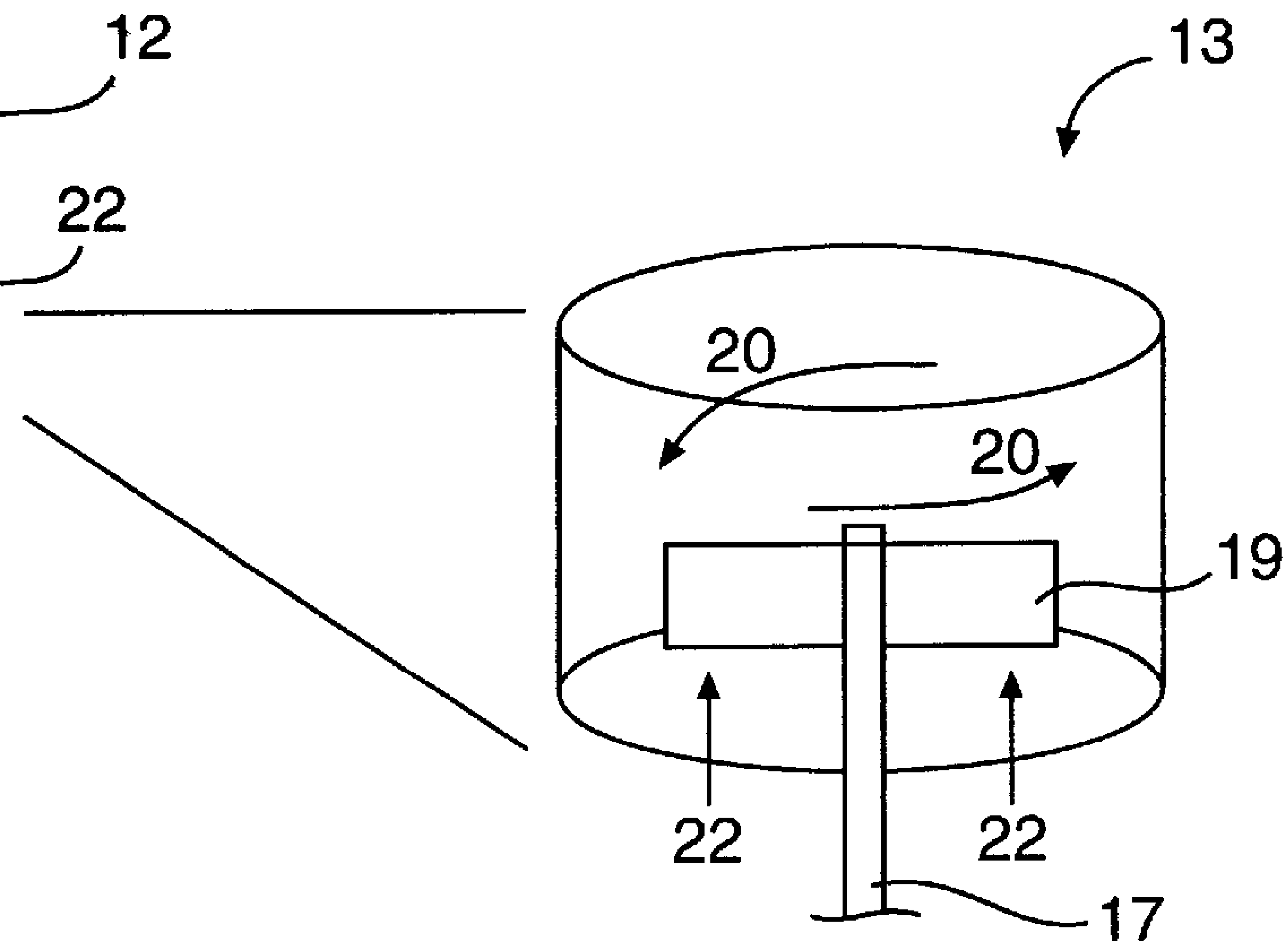


FIG. 1B

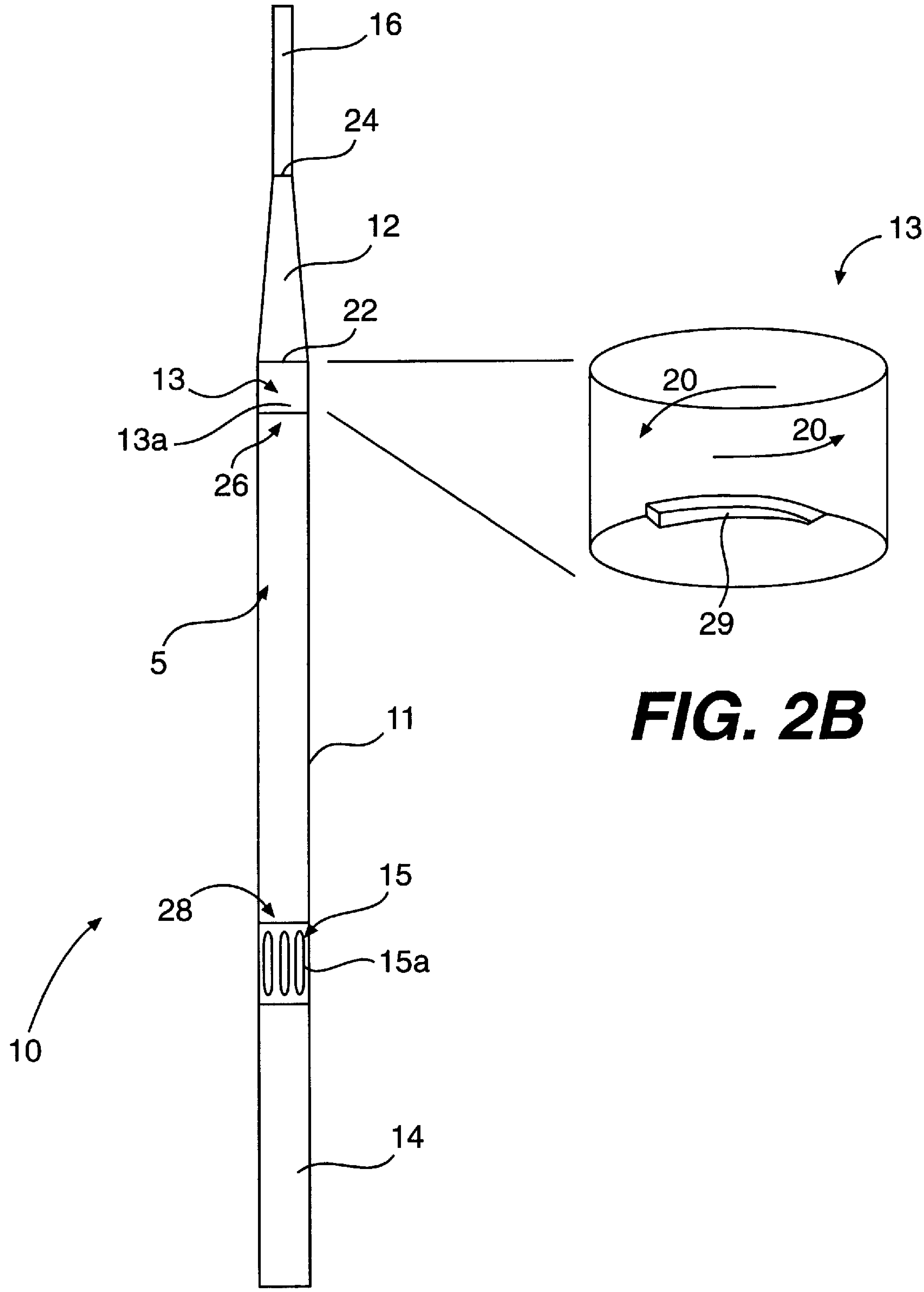


FIG. 2B

FIG. 2A

METHOD AND APPARATUS FOR MINIMIZING EMULSION FORMATION IN A PUMPED OIL WELL

The present application claims priority under 35 U.S.C. §119(e) to provisional application Ser. No. 60/059,731, filed Sep. 23, 1997, the entirety of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus and method for enhanced production of hydrocarbons from a producing well. In particular, the present invention relates to an improved apparatus and method for enhancing the downhole separation of hydrocarbons and water produced from earth formations penetrated by a wellbore and for lifting viscous fluids from the wellbore.

2. Related Art

Conventional hydrocarbon (e.g., crude oil, natural gas, or gas condensate) production wells have been constructed in subterranean strata that yield both hydrocarbons and an undesired amount of water, such as salt water. In many of these wells, the natural pressure in the producing earth formation or reservoir is insufficient to propel or push the fluid produced from the formation to the surface of the earth. In such instances, it is necessary to use artificial lift systems to convey the produced fluids to the ground surface.

Some hydrocarbons, for example, crude oil, have a low viscosity and are relatively easy to pump from the subterranean reservoir. Others have a very high viscosity even at reservoir conditions and present numerous difficulties when attempting to bring such fluids to the ground surface.

Sucker rod pumps may be used to lift viscous hydrocarbons, but in many fields, sucker rod pumps cannot be used. For example, rod pumps are not feasible in highly deviated wells and, in many fields, limited surface rights make sucker rod pumps unfeasible.

A number of pumps such as electrical submersible pumps, electrical submersible progressive cavity pumps, and axial flow pumps have been used when sucker rod pumps, or other types of lifting systems, are not feasible. In such systems, the use of such pumps has been proposed for either the reinjection of produced water downhole, or for the artificial lifting of produced hydrocarbons to the surface. One problem in using such pumps as an artificial lift method is that they tend to impart a high shear on the produced fluids as they pass through the pump. If the well is producing both oil and water, this high shear can lead to the formation of emulsions of oil and water having very small droplet size. Such emulsions may be referred to as "tight emulsions." These emulsions may be difficult and expensive to separate in surface separation facilities.

Two examples of such systems utilizing electrical submersible pumps, for example, are shown in U.S. Pat. Nos. 4,832,127 and 4,749,034. These inventions mix water with the crude oil at relatively high shear rates to force an emulsion to form in the pump. The emulsion has an effective viscosity less than the viscosity of the crude oil because it is water continuous rather than oil continuous. These inventions make it possible to produce oils otherwise not capable of being produced by electrical submersible pumps, but an excessive amount of water injection from the ground surface is required. For example, the process of U.S. Pat. No. 4,832,127 utilizes from 300 to 1,200 barrels of water per day to produce about 225 barrels of oil. This excessive amount of water results in larger pumps, motors, and surface separation equipment. Further, because an emulsion is created, surface separation equipment must be capable of breaking the emulsion.

If such emulsions have an oil-continuous phase (i.e., a "water-in-oil emulsion" having water droplets dispersed in an oil medium), they may also possess a viscosity that can be much higher than that of the base crude oil. The increased viscosity can then result in the use of additional energy to pump the resulting emulsion through production tubing to the surface.

To overcome this problem, several devices and schemes have been proposed to separate the oil and water downhole thereby minimizing or eliminating the formation of the oil/water emulsion. Some of these systems rely on the downhole natural gravity separation of the oil and water. Other systems, however, rely on known separation devices, such as hydrocyclones, which divide the oil and water into separate streams to be handled in separate, individual tubing strings. The separated oil can then be pumped to the surface and the separated water can be disposed of downhole or be pumped to the ground surface via the separate tubing.

Other proposed systems, such as the system shown in U.S. Pat. No. 5,159,977, utilize oil/water core flow at the pump inlet in order to reduce electrical motor temperature rise and the frictional pressure drop in the production tubing while increasing pump efficiency. However, this invention requires water to be injected from the ground surface, albeit less than prior known systems, which may result in larger pumps, motors, and surface separation equipment.

Methods for establishing core annular flow in pipelines have been disclosed in, for example, U.S. Pat. Nos. 3,977,469, 4,047,539, 4,745,937, and 4,753,261. These processes establish a core flow of a viscous fluid within a core of a less viscous fluid in order to reduce the pressure drop in the pipeline. These inventions, however, do not disclose or suggest an apparatus or method to consistently create core annular flow at the outlet of an electrical submersible pump, electrical submersible progressive cavity pump, or an axial flow pump.

Generally, these pumps may be used in relatively high rate wells where natural (gravity) separation in the wellbore would not occur. The conventional method of achieving downhole separation in wells utilizing such pumps would require the use of a hydrocyclone at the inlet of the pump and two separate pumps at the outputs of the hydrocyclone to handle the separated water and oil streams.

Thus, there is a need in the art for an apparatus and method that substantially obviates one or more of the limitations and disadvantages of conventional pumping systems. Particularly, it would be highly desirable to provide such a pump which does not impart undue shear to the produced oil and water. This would reduce or substantially eliminate the formation of an oil/water emulsion. Furthermore, it would be desirable to provide a pump that could enhance the separation of produced oil and water downhole without requiring the injection of excess water from the ground surface.

SUMMARY OF THE INVENTION

In one aspect of the present invention, a pump is provided for conducting produced fluids from a producing well to a ground surface. The invention includes a pump section, and a pump outlet disposed at one end of the pump section and in fluid flow communication with the pump section. A transition conduit having an inlet and an outlet is coupled to the pump outlet. The pump outlet is configured to accelerate produced fluids in a tangential direction toward the transition conduit so that produced fluids exiting the transition conduit are in substantially core annular flow. The invention also includes an outlet conduit in fluid flow communication with the transition conduit for conducting produced fluids to the ground surface.

In another aspect of the present invention, a method for conducting produced fluids, including hydrocarbons and water, from a producing well to a ground surface is provided.

The method includes pumping produced fluids through a pump section into a pump outlet disposed at one end of the pump section. The method further includes accelerating the produced fluids entering the pump outlet in a substantially tangential direction and towards an inlet of a transition conduit coupled to the pump outlet. In addition, the method includes forcing the accelerated produced fluids through the transition conduit thereby further accelerating the produced fluids in the tangential direction and increasing the centripetal and centrifugal forces acting on the produced fluids such that the produced hydrocarbons and produced water separate into substantially core annular flow. The method further includes conducting the separated hydrocarbons and water up an outlet conduit to the ground surface.

FEATURES AND ADVANTAGES

The present invention provides an improved pump to enhance oil and water separation within the pump, preferably, at its outlet. The improved pump, at least partially, breaks any oil and water emulsion created by its pump section and causes separated water to be conducted radially outwardly, preferably in the pump outlet to the wall of the tubing outlet. The oil and any remaining emulsion may be located geometrically near the axis or center portion of the tubing. This radial distribution of the fluid results in what is generally known as "core annular flow," wherein the heavier water tends toward the outside of the wall of the tubing outlet while the oil tends to stay toward the central axis of the tubing outlet as the fluids flow through the tubing.

The promotion of core annular flow results in several advantages. Among these are: 1) reducing the effective viscosity of the emulsion; 2) reducing drag along the tubing wall; 3) reducing the "tightness" of the emulsion, thereby increasing the effectiveness of the separation facilities at the ground surface; 4) reducing the amount of chemical emulsion breaker and/or facilities required for separation; 5) increasing the throughput of the separation facilities without adding additional equipment; and 6) simplifying the equipment required for downhole separation. Core annular flow may, however, be relatively short lived if the viscosity of the inner (radial) fluid is much less than 1000 centipoise. Even if core annular flow cannot be sustained along the entire length of the outlet tubing to the ground surface, there are large advantages in separating the oil and water into two phases, rather than producing the mixture as a tight emulsion which is difficult and expensive to separate at the ground surface.

In the present invention, the preferred embodiments of the improved pump accelerate the oil/water emulsion in a tangential direction as it is exiting from the pump outlet. Separation occurs because of an increase in centrifugal force (which is generally discussed in terms of the gravitational constant or "g") which pulls the heavier fluid component (e.g., water) to the outside of the boundary of the device (e.g., tubing) and a corresponding increase in centripetal force which forces the lighter fluid component (e.g., oil) to the center or axis of the device. A major difference between using the pump system of the present invention from the use of conventional hydrocyclone separators is that in the present invention a single output tubing string transports the separated fluids in substantially core annular flow to the ground surface. This reduces the amount of, and complexity of, the equipment used downhole to separate the oil and water.

Moreover, the present invention overcomes the problems with conventional systems in that it substantially separates the emulsion of oil and water at the outlet of the pump. Furthermore, the present invention provides a pump that enhances the separation of produced oil and water downhole without requiring the injection of excess water from the ground surface.

The invention may best be understood by the following detailed description taken in conjunction with the accompanying drawings. These descriptions and drawings are intended as illustrative of the invention and should not be construed as limitations thereon.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the features, advantages, and principles of the invention.

FIG. **1***a* is a schematic sectional view of an embodiment of the present invention showing a pump with a pump outlet;

FIG. **1***b* is a schematic detailed view of an exemplary pump outlet according to the present invention;

FIG. **2***a* is a schematic sectional view of a second embodiment of the present invention showing a pump with a pump outlet; and

FIG. **2***b* is a schematic detailed view of a second exemplary pump outlet according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. The exemplary embodiments of this invention are shown in some detail, although it will be apparent to those skilled in the relevant art that some features which are not relevant to the invention may not be shown for the sake of clarity.

Referring to FIG. **1***a,* there is illustrated, in a schematic sectional view, an exemplary embodiment of the present invention and is represented generally by the reference numeral **10**. A pump, shown generally by the reference numeral **5**, preferably includes a pump section **11**. Pump **5** is preferably an electrical submersible pump, and more preferably, an electrical submersible centrifugal pump. In such an embodiment, pump section **11** preferably includes a series, or plurality, of impeller or centrifugal pump stages, each pump stage including one or more impellers. In an alternate embodiment of the present invention, pump **5** is an electrical submersible progressive cavity pump. In such an embodiment, pump section **11** includes one or more progressive cavity pump stages, each of which includes a rotor and a stator. An exemplary electrical submersible progressive cavity pump suitable for use with the present invention is shown in U.S. Pat. No. 3,677,665, the entirety of which is incorporated herein by reference. In a further alternate embodiment of the present invention, pump **5** is an axial flow pump. In such an embodiment, pump section **11** preferably includes one or more axial flow stages, each of which preferably includes an impeller and a stator, or a rotor and a stator. Exemplary axial flow pumps suitable for use with the present invention are shown in U.S. Pat. Nos. 5,562,405 and 5,755,554, the entirety of both of which are incorporated herein by reference.

Pump section **11** is preferably driven by an electric motor which is encased within a motor section **14** at the lower end of pump **5**. Preferably, motor or motor section **14** is disposed below pump section **11**. The placement of motor **14** will, of course, depend on various factors, such as the size of motor **14** or the dimensions of the producing well.

A pump outlet **13** is shown disposed at an upper end **26** of pump section **11** and preferably in fluid flow communication with pump section **11**. It should be understood by one skilled in the art that the present invention embraces the use of more than one pump outlets **13**. For example, it may be necessary to use two or more pump outlets **13** in order to provide separation of the oil and water which results in substantially core annular flow as will be described in more detail below.

A transition conduit **12** is shown connected to pump outlet **13** and in fluid flow communication therewith. Transition conduit **12** may preferably be connected or attached at its inlet **22** to a housing **13***a* of pump outlet **13** by any suitable method, such as, but not limited to, welding or via threaded connections. Additionally, transition conduit **12** may preferably be connected at its outlet **24** to a fluid outlet conduit **16** by any suitable method.

As shown in FIG. **1***a,* transition conduit **12** preferably tapers from a larger cross-sectional area at inlet **22** to a smaller cross-sectional area at outlet **24**. This reduction in surface area causes produced fluids which flow into inlet **22** of transition conduit **12** from pump outlet **13** to be accelerated in a tangential direction which will be described in more detail below. Preferably, transition conduit **12** is conical in shape and therefore the surface areas at inlet **22** and outlet **24** are circular. It should, however, be apparent to one of ordinary skill in the art that transition conduit **12** may be other suitable shapes as long as the further tangential acceleration of the produced fluids flowing through transition conduit **12** can be maintained.

Fluid outlet conduit **16**, as noted above, is preferably connected to transition conduit **12** by any suitable method. Fluid outlet conduit **16** may be a production tubing string which extends from the ground surface downwardly through the well. Fluid outlet conduit **16** is in fluid flow communication with transition conduit **12** thereby providing a flow path to the ground surface for the separated produced fluids which will be described in more detail below. Pump **5** may also be suspended in the production well from fluid outlet conduit **16**.

An inlet **15** is preferably disposed at a lower end **28** of pump section **11**. As shown in the exemplary embodiment in FIG. **1***a,* inlet **15** may be sets of perforations **15***a*. Alternatively, inlet **15** may be a port or multiple ports or other suitable mechanisms for conducting fluid flow. Preferably, however, inlet **15** will be sets of perforations **15***a*. Inlet **15** is configured to permit the produced fluids to enter pump section **11** which will be described in more detail below.

Reference will now be made to the operation of the first embodiment as shown in FIGS. **1***a* and **1***b*. In FIG. **1***b,* pump outlet **13** is shown in more detail, but still schematically. A drive shaft **17** is shown (in partial view) extending from motor **14** into pump outlet **13** where it is connectable to preferably a pair of rotating vanes **19**. It should be understood by one of ordinary skill in the art that any number of rotating vanes **19** may be used, for example, one, two, or more than two, depending on the amount of fluid acceleration desired and the physical limitations of pump **5**. As shown in FIG. **1***b,* rotating vanes **19** are preferably rectangular in shape but it should be apparent that other shapes are embraced by the present invention.

As produced fluids (i.e., hydrocarbons and water) are withdrawn from a subterranean reservoir, the produced fluids are drawn into pump section **11** of pump **5** through perforations **15***a*. The produced fluids are transported through pump section **11** in a well-known manner. The produced fluids exiting pump section **11** enter pump outlet **13** in an axial direction (as shown by arrows **22** in FIG. **1***b*). Once inside pump outlet **13**, the rotation of vanes **19** causes the produced fluids entering axially from below to be tangentially accelerated in the direction of arrows **20** and simultaneously forced to inlet **22** of transition conduit **12**. As the produced fluids are forced through transition conduit **12** toward outlet **24**, or narrower end of transition conduit **12**, the reduction in diameter of conical transition conduit **12** causes further tangential acceleration of the fluids.

The further tangential acceleration of the produced fluids within transition conduit **12** increases the centripetal and centrifugal forces, or "g" forces, acting on the produced fluids. This tends to cause separation of the produced oil and water as they are forced toward outlet **24**. The heavier water tends toward the outside or wall of outlet conduit **16** while the oil and any remaining oil/water emulsion stay toward the central axis of outlet conduit **16**. This separates the produced fluids into substantially a core annular flow regime of the oil and water in outlet conduit **16**. The separated produced fluids continue up outlet conduit **16** to the ground surface where they may be collected in a suitable manner.

Reference will now be made to FIG. **2***a*, where a second embodiment of the present invention is shown schematically. Like reference numerals will be used where appropriate to describe similar elements to those of the embodiment shown in FIGS. **1***a* and **1***b*.

Referring to FIG. **2***a*, there is illustrated, in a schematic sectional view, a second exemplary embodiment of the present invention and is represented generally by the reference numeral **10**. A pump, shown generally by the reference numeral **5**, preferably includes a pump section **11**. Pump **5** is preferably an electrical submersible pump and pump section **11** preferably includes a series, or plurality, of impeller or centrifugal pump stages, the configuration of which would be readily apparent to one of skill in the art. In a manner similar to that discussed with respect to FIGS. **1***a* and **1***b,* pump **5** can also be an electrical submersible progressive cavity pump or a weir pump.

Pump section **11** is preferably driven by an electric motor that is encased within motor section **14** at the lower end of pump **5**. Preferably, motor or motor section **14** is disposed below pump section **11**. In addition, inlet **15** is preferably disposed at a lower end of pump section **11**.

An alternate embodiment of pump outlet **13** is shown disposed at upper end **26** of pump section **11** and preferably in fluid flow communication with pump section **11**. Transition conduit **12** is also shown connected to a housing **13***a* of pump outlet **13** and in fluid flow communication therewith.

As noted above with respect to FIG. **1***a,* and as shown in FIG. **2***a*, transition conduit **12** preferably tapers from a larger cross-sectional area at inlet **22** to a smaller cross-sectional area at outlet **24**. This reduction in surface area causes produced fluids which flow into the inlet **22** of transition conduit **12** from pump outlet **13** to be accelerated in a tangential direction which will be described in more detail below.

Fluid outlet conduit **16** is provided and is preferably connected to transition conduit **12** by any suitable method. Fluid outlet conduit **16** may be a production tubing string which extends from the ground surface downwardly through the well. Fluid outlet conduit **16** is in fluid flow communication with transition conduit **12** thereby providing a flow path for the separated produced fluids to the ground surface which will be described in more detail below. The pump **5** may also be suspended in the production well from fluid outlet conduit **16**.

Reference will now be made to the operation of the second embodiment as shown in FIGS. **2***a* and **2***b*. In FIG. **2***b*, pump outlet **13** is shown in more detail, but still schematically. An output nozzle **29**, in fluid flow communication with pump section **11**, is disposed in pump outlet **13** as shown in FIG. **2***b*. Nozzle **29** is configured to accelerate t he produced fluids entering pump outlet **13** from pump section **11** in a substantially tangential direction which will be described below. It should be understood by one of ordinary skill in the art that a plurality of nozzles may be employed in the present invention depending, of course, upon the p articular characteristics of the producing well.

As produced fluids (i.e., hydrocarbons and water) are withdrawn from a subterranean reservoir, the produced fluids are drawn into pump section **11** through perforations **15***a*. The produced fluids are transported through the plurality of pump stages disposed in pump section **11** in a suitable manner. As the produced fluids exit pump section **11** and enter pump outlet **13**, nozzle **29** disposed therein accelerates the produced fluids in a tangential direction, as shown by arrows **20**, within pump outlet **13**. Simultaneously, the produced fluids are forced towards inlet **22** of transition conduit **12**. As the produced fluids are forced through transition conduit **12** toward outlet **24**, or narrower end of transition conduit **12**, the reduction in diameter of conical transition conduit **12** causes further tangential acceleration of the fluids resulting in separation of the produced fluids and substantially core annular flow through outlet conduit **16** to the ground surface as described above.

CONCLUSION

While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example only, and not limitation. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

We claim:

1. A pump for conducting produced fluids from a producing well to a ground surface comprising:

a pump section comprising an upper end and a lower end;

a pump outlet disposed at one end of said pump section and in fluid flow communication with said pump section;

a transition conduit having an inlet and an outlet coupled to said pump outlet, wherein said pump outlet is configured to accelerate produced fluids in a tangential direction toward said transition conduit and wherein produced fluids exiting said transition conduit are in substantially core annular flow; and

an outlet conduit in fluid flow communication with said transition conduit for conducting produced fluids to the ground surface.

2. The pump according to claim **1**, wherein said pump outlet comprises a rotating vane, said rotating vane capable of causing produced fluids entering said pump outlet in an axial direction to be accelerated in a tangential direction toward the inlet of said transition conduit.

3. The pump according to claim **2**, wherein said transition conduit tapers from a larger cross-sectional area at the inlet of said transition conduit to a smaller cross-sectional area at the outlet of said transition conduit, thereby causing the produced fluids to be further accelerated in the tangential direction.

4. The pump according to claim **1**, wherein said transition conduit tapers from a larger cross-sectional area at the inlet of said transition conduit to a smaller cross-sectional area at the outlet of said transition conduit, thereby causing the produced fluids to be further accelerated in the tangential direction.

5. The pump according to claim **4**, wherein said transition conduit is conical.

6. The pump according to claim **1**, wherein said outlet conduit is a tubing string extending from the ground surface and coupled to the outlet of said transition conduit.

7. The pump according to claim **1**, wherein said pump outlet comprises a nozzle, said nozzle configured to cause produced fluids entering said pump outlet to be accelerated in a tangential direction toward the inlet of said transition conduit.

8. The pump according to claim **7**, wherein said transition conduit tapers from a larger cross-sectional area at the inlet of said transition conduit to a smaller cross-sectional area at the outlet of said transition conduit, thereby causing the produced fluids to be further accelerated in the tangential direction.

9. The pump according to claim **8**, wherein said transition conduit is conical.

10. The pump according to claim **1**, further comprising:

an inlet disposed at an end of said pump section remote from said one end, said inlet configured to conduct produced fluids into said pump section.

11. The pump according to claim **1**, further comprising:

a motor for driving said pump section.

12. The pump according to claim **11**, wherein said motor is disposed below said pump section.

13. The pump according to claim **1**, wherein said pump section comprises an impeller.

14. The pump according to claim **1**, wherein said pump section comprises a rotor and a stator.

15. The pump according to claim **14**, wherein said rotor and said stator are disposed in an axial flow stage.

16. The pump according to claim **14**, wherein said rotor and said stator are disposed in a progressive cavity pump stage.

17. The pump according to claim **1**, wherein said pump section comprises an impeller and a stator.

18. The pump according to claim **1**, wherein said pump section comprises a plurality of pump stages.

19. A method for conducting produced fluids, including hydrocarbons and water, from a producing well to a ground surface comprising the steps of:

pumping produced fluids through a pump section into a pump outlet disposed at an end of the pump section;

accelerating the produced fluids entering the pump outlet in a substantially tangential direction and towards an inlet of a transition conduit coupled to the pump outlet;

forcing the accelerated produced fluids through the transition conduit thereby further accelerating the produced fluids in the tangential direction and increasing the centripetal and centrifugal forces acting on the produced fluids such that the produced hydrocarbons and produced water separate into substantially core annular flow; and

conducting the separated hydrocarbons and water up an outlet conduit to the ground surface.

20. The method according to claim **19**, wherein the accelerating step is performed using a rotating vane disposed in the pump outlet.

21. The method according to claim **19**, wherein the accelerating step is performed using a nozzle disposed in the pump outlet.

22. The method according to claim **19**, further comprising the step of:

collecting the substantially separated hydrocarbons and water at the ground surface.

* * * * *